The wanted change against climate change: assessing the role of organic farming as an adaptation strategy

Sreejith Aravindakshan and Aliyaru Kunju Sherief

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AK Sherief and A Sreejith[1]

Training Service Scheme, Department of Agricultural Extension, KAU
[1]IRCA, United Kingdom Certified Environmental Management System Lead Auditor

Abstract

Conventional input intensive agriculture practiced over the last century has been a major contributor to climate change, second only to energy sector. The communities engaged in pesticide and synthetic input rich agriculture is most vulnerable to the impacts of climate change. Many emerging economies including India have had the opportunity to develop National Adaptation Plans of Action in the context of the United Nations Framework Convention on Climate Change but implementation of those programmes and strategic links to resourcing actions are often lacking. Adaptation in the agricultural sector can be seen in terms of both short-term and long-term actions. Changing to organic farming systems is the most efficient and long term adaptation strategy. Organic agriculture is believed to be the most sustainable approach against climate change ensuring food security; it employs low external input and high output strategies.

This paper attempts to review the potent role of organic agriculture as an adaptation strategy to deliver a tangible and hopeful alternative towards sustainable livelihood in the backdrop of climate change. The methodology involves thorough review of scientific literature. The study discusses the carbon sequestration achieved as well as reduction in emission with respect to low pesticide use and fossil fuel based farm machinery use in organic farming. The analysis of results concludes that the organic system of farming is the most resilient adaptation strategy against climate change and offer greater potential as a sustainable livelihood mechanism in times of climate transition.

by

ALIYARU KUNJU SHERIEF and SREEJITH ARAVINDAKSHAN

Introduction

The Bali Road Map should lead to a Copenhagen agreement that commits to climate stabilisation, and an efficient result at COP 15 in Copenhagen in December is expected. It should address feasible policies for effective climate change adaptation and mitigation. Conventional input intensive agriculture practised over the last century has been a major contributor to climate change, second only to energy sector (World Development Report 2008). The communities engaged in pesticide and synthetic input rich agriculture is most vulnerable to the impacts of climate change. As adaptation is unavoidable, one key point is the integration of agriculture which accounts for 10-12% of global emissions (Smith *et al.,* 2007) in a post-2012 agreement. Its main potential lies in its significant capacity to sequester CO_2 in soils, and in its synergies between mitigation and adaptation. This potential is best utilized employing sustainable agricultural practices such as organic farming or organic agriculture (OA). Conservative estimates of the total mitigation potential of OA amount to 4.5-6.5 Gt CO_2eq/yr, i.e. of ca. 50 Gt CO_2eq total global greenhouse gas emissions (Muller A. *et al.,* 2009). Depending on agricultural management practices, much higher amounts seem however possible. Sustainable, organic, ecological friendly agriculture, which is owned, controlled and managed by small men and women farmers, and supported by government policies and programs, is a strategic agricultural measure to adapt and mitigate climate change, ensure food security and sustainable livelihood and to reduce poverty among smallholder farmers.

Study objective

The objective of the study is to review the potent role of organic agriculture as an adaptation strategy to deliver a tangible and hopeful alternative towards sustainable livelihood in the backdrop of climate change.

Methods and scope

The methodology involves thorough review of scientific literature. The research done in Europe, United States and developing countries in Asia and Africa are collated and extrapolated as background information for future research. Many emerging economies including India have had the opportunity to develop National Adaptation Plans of Action in the context of the United Nations Framework Convention on Climate Change but implementation of those programmes and strategic links to resourcing actions are often lacking. Apropos, the present study may initiate positive policy implications towards climate change adaptation in India.

Review results and analysis

The research results from various parts of the globe on organic farming and its adaptation potential against climate transition has been presented. The results has been analysed with respect to carbon sequestration, energy efficiency, emission reduction and livelihood security.

Climate change adaptation race: organic farming versus conventional farming

Organic farming differs primarily from conventional farming in terms of fertilizer type and usage, pest and disease management, crop rotation and use of fossil fuel based agro machinery (Elmaz *et al.,* 2004). One goal of organic farming is to reduce the dependency of agricultural production on external inputs. It is frequently claimed that organic farming provides environmental benefits, many of which relate to soil properties. Adopted crop rotations may reduce soil erosion (Eltun *et al.,* 2002). Replacement of mineral fertilizer and pesticides by organic fertilizers enhance soil biological activity, efficiency, and rate of microbial substrate use (Gunapala and Scow, 1998). Positive effects of organic farming on soil carbon have been reported repeatedly (e.g., Drinkwater *et al.,* 1998; Liebig and Doran, 1999; Wells *et al.,* 2000).

The FAO report 2007 found that, "Organic agriculture performs better than conventional agriculture on a per hectare scale, both with respect to direct energy consumption (fuel and oil) and indirect consumption (synthetic fertilizers and pesticides)", with high efficiency of energy use.

Carbon sequestration capacity of organic farming

One of the best-documented, longest-lasting planned comparisons of organic vs. conventional farming is the DOK (D: biodynamic, O: bioorganic, K: conventional) experiment in Switzerland (Mäder *et al.,* 2002). In a 7-yr crop rotation study, conventional systems with or without organic fertilizer are compared with organic and biodynamic farming practices. The study showed that organic agriculture increases soil organic matter and observed to have increased carbon sequestration capacity. As a result, soils in organic agriculture capture and store more water than soils of conventional cultivation. OA production is thus less prone than conventional cultivation to extreme weather conditions, such as drought, flooding, and water logging. Soils under organic management practices are also less prone to erosion. Organic agriculture accordingly addresses key consequences of climate change, namely increased occurrence of extreme weather events, increased water stress and drought.

Research on established organic crop farming systems shows superior soil carbon sequestration over both conventional and no-till systems (Comis, D. 2007). One of the longest running and most notable studies comparing the carbon sequestration ability of organic and conventional systems is the Rodale Institute's Farming Systems Trial®. In this study, organic systems showed an increase of almost 30 percent in soil carbon over 27 years while the conventional system showed no significant increase in soil carbon over the same time period.

The 9-years study by John Teasdale and colleagues at the USDA Agricultural Research Service's Sustainable Agricultural Systems Laboratory of data comparing various 19 no-till systems to organic systems indicate that despite the need for tillage to control weeds in the organic system, the carbon and available nitrogen concentrations were higher at all soil depths in the organic system. Work at other research centres, including the University of California at Davis, University of Illinois, and Iowa State University corroborate the results of the Rodale study (Khan, S. et al 2007). Their research demonstrates a vast, untapped potential of organic farming systems to adapt to climate change by increasing soil carbon storage. The Rodale Institute estimates that organic agriculture, if practiced on the planet's 3.5 billion tillable acres, could sequester nearly 40 percent of current CO_2 emissions. Current estimates are that 70 to 220 Tg CO_2 eq could be added to agricultural soils over two decades (Paustian, K. *et al.,* 2006).

Organic agriculture and emission reduction

Organic systems avoid the use of synthetic fertilizers, relying on practices such as green manures, the addition of nitrogen fixing crops to rotations and the use of composted animal manures. In addition, organic systems avoid the use of synthetic pesticides and rely on practices such as crop rotations which break up pest cycles and increase beneficial insects. These restrictions on fossil-fuel based fertilizer and pesticide inputs can significantly reduce the overall GHG footprint of organic systems in comparison to conventional production systems. The U.S EPA estimates that once on soils, synthetic fertilizers generate over 304 million tons of GHG emissions each year. Current estimates are that over one billion pounds of synthetic pesticides are used by agriculture each year (Ritter, Steven, 2009). Organic agriculture has lower N_2O emissions from nitrogen application, due to lower nitrogen input than in conventional agriculture. This leads to a potential emission reduction of 1.2-1.6 Gt CO_2eq (Niggli *et al.,* 2009). In organic agriculture, biomass is not burned. This reduces the CH_4 and N_2O emissions by ca.0.6-0.7 Gt CO_2eq in comparison to conventional agriculture, where crop residues are often burnt on the field (Smith *et al.,* 2007). Ca. 1% of global fossil energy consumption is used for chemical nitrogen fertilizer production, emitting ca. 0.23 Gt CO_2eq (IPCC, 2007b). Organic agriculture avoids these emissions, as no chemical nitrogen fertilizers are used and nitrogen input stems from application of manure and compost, or is fixed from the air by leguminous plants.

Conventional stockless arable farms depend on the input of synthetic nitrogen fertilizers, while manure and slurry from livestock farms create additional environmental problems. For both these farm types, high emissions of CO_2, N_2O and CH_4 are likely. Organic farms prevent such problems by on-farm or cooperative use of farmyard manure between both crop and livestock operations.

Organic agriculture and climate change induced livelihood risk

Organic agriculture is a low-risk farming strategy based on lowering external chemical inputs and optimizing biological functioning (Muller A., 2009). Besides lowering toxicity, reduced input costs make organic agriculture competitive economically. In addition, organic price premiums can be realized. These factors working together lower the financial risks and improve the rewards. They provide a type of low cost but effective insurance against crop reduction or failure (Fig. 1). A comparison of energy use efficiency of different production systems shows that low input , less fossil fuel based organic agriculture is more energy efficient than conventional/ chemical farming (Fig. 2). Thus it clearly depicts an optimistic picture on organic farming as the most wanted adaptation strategy against climate change ensuring sustainable livelihood among vulnerable communities.

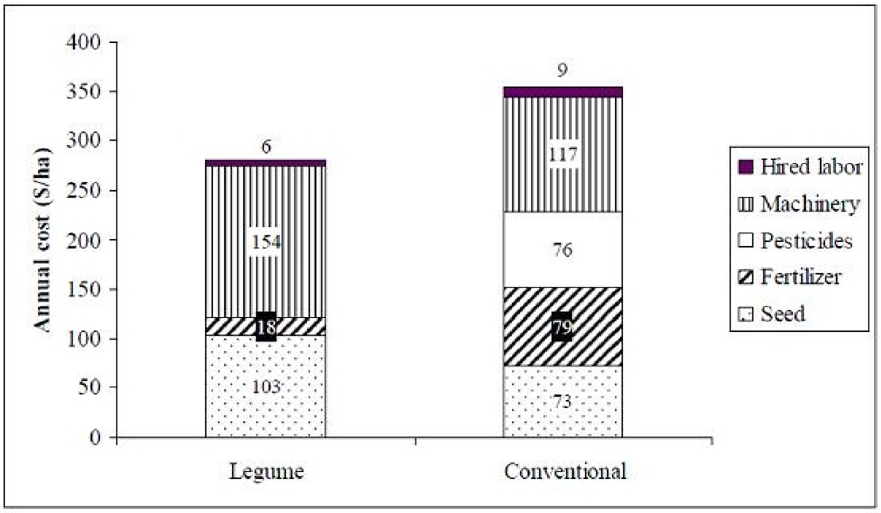

Fig. 1: Annual input costs ($/ha) for the organic –legume system and conventional system of farming, The Rodale Institute Farming Trial (Source: Hanson & Muller 2003).

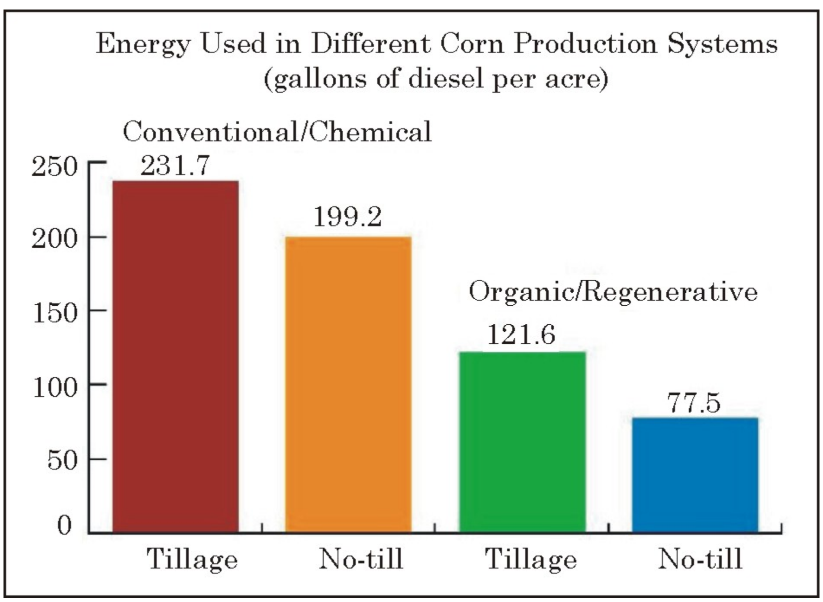

Fig. 2. Energy used in different crop production systems

Source: Pimentel. D., 2006, Impacts of organic faming on efficiency and energy use in agriculture. www.organicvalley.coop/fileadmin/pdf/ENERGY_SSR.pdf. 40 pages.

Since the coping capacity of the farms is increased, the risk of indebtedness in general is lowered. Organic agriculture is thus a viable alternative for poor farmers. Risk management, risk-reduction strategies, and economic diversification to build resilience are also prominent aspects of adaptation, as mentioned in the Bali Action Plan (UNFCCC, 2007).

OA has the best premises to utilize local and indigenous farmer knowledge, adaptive learning and crop development, which are seen as important sources for adaptation to climate change and variability in farming communities. In addition, the certification available for products of OA allows realization of higher prices (Muller A., 2009).

Organic agriculture the resilient system

Organic agriculture is a resilient system of agriculture that uses crop rotation, green manure, compost, biological pest control, and mechanical cultivation to maintain soil productivity and control for pests. Organic agriculture does not use synthetic fertilizers or pesticides, plant growth regulators, livestock feed additives or genetically modified organisms. Research also indicates that organic production systems are more resilient than conventional systems under both flood and drought conditions (Bescansa P. *et al.,* 2006). This resilience is crucial in the backdrop of a changing climate where more weather extremes are projected. The permutation of practices, including crop rotation and crop diversification, create a system that can literally "weather" the extremes. Organic agricultural systems with organically managed soils are better adapted to weather extremes. These soils can better retain moisture, which can alleviate the impact of periodic droughts. These systems also retain more water during high rainfall events and release the water more slowly. At the landscape level, this increased water retention capacity helps decrease the severity of flooding from high rainfall events (The National Sustainable Agriculture Coalition, 2009). This is particularly significant with regard to humid tropics with undulating terrain and heavy precipitation as Kerala.

Many organic systems also incorporate a wider array of multi-season crops. The greater biodiversity of most organic systems increases their ability to adapt to climate change, while continuing to provide both economic and ecosystem benefits (International Trade Centre, 2007). Without sacrificing the yields of conventional agriculture (Delate, K., C.A. Cambardella, 2004) organic farming systems provide benefits to water quality, biodiversity, rural communities and human health. Organic systems provide a promising solution to mitigating the progression of climate change and adapting to its effects (Niggli, U. and *et al.,* 2009). The advantage of OA is that it comprises a bundle of mutually adapted and optimized practices and is thus a whole operational farming system with a proven record of good performance.

Conclusion

The study concludes that the organic system of farming is the most resilient adaptation strategy against climate change and offer greater potential as a sustainable livelihood mechanism in times of climate transition.

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